

MEDICAL BIOCHEMISTRY EXAMINATION I - FORM A

September 22, 1997

DIRECTIONS: For the following questions, select the one best answer or completion.

1. Precursors of DNA include:
 - A. ribose, adenine, phosphate
 - B. cytidine, glycerol
 - ☒ C. deoxyribose, guanine, phosphate
 - D. ribose, uracil, phosphate
 - E. deoxyribose, uracil
2. If in an aqueous solution the $[H^+] = 10^{-6}$ M, then $[OH^-]$ is:
 - A. 1.8×10^{-10} M
 - B. 10^6 M
 - C. 10^{-14} M
 - D. 10^{-6} M
 - ☒ E. 10^{-8} M
3. An amino acid with two amino groups is:
 - A. alanine
 - ☒ B. lysine
 - C. glycine
 - D. leucine
 - E. serine
4. The hydrophobic effect:
 - ☒ A. is of minor importance for the structure of proteins.
 - B. is enhanced if the polarity of the aqueous solvent is reduced.
 - ☒ C. results in the sequestering of hydrophobic groups.
 - ☒ D. increases the amount of contact between water and nonpolar groups.
 - E. is primarily due to the enthalpy of interactions between water and hydrophobic groups.

$$\Delta G = \Delta H - T\Delta S$$

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5. Which of the following statements about Gibbs free energy is FALSE?

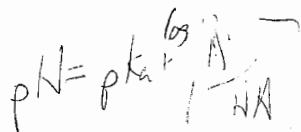
- ☐ A. Gibbs free energy change is affected by changes in enthalpy and entropy.
- ☐ B. Gibbs free energy change depends on the equilibrium constant and the concentrations of the reactants and products.
- ☐ C. Gibbs free energy change is dependent on temperature.
- ☐ D. The standard free energy change can be calculated, given the equilibrium constant and temperature.
- ☒ E. A negative Gibbs free energy change indicates the reaction is unfavorable.

6. Which of the following pathways or reactions generates reducing equivalents?

- ☐ A. gluconeogenesis
- ☒ B. pentose phosphate pathway
- ☐ C. fatty acid biosynthesis
- ☐ D. cholesterol biosynthesis
- ☒ E. conversion of triacylglycerols to fatty acids



7. The pK value is 6.8 for the following ionization step:



The ratio of $[\text{HPO}_4^{2-}]/[\text{H}_2\text{PO}_4^-]$ in a patient's urine sample is 0.1. The pH of this urine sample is:

- ☒ A. 5.8
- ☐ B. 6.7
- ☐ C. 6.8
- ☐ D. 6.9
- ☐ E. 7.8

$$\text{pH} = \text{pK} + \log_{10} 0.1$$

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8. Given that the standard free energy change (ΔG°) for hydrolysis of ATP is -7.3 kCal/mol and that for the hydrolysis of glucose-6-P is -3.3 kCal/mol, what is the ΔG° for phosphorylation of glucose?

- ☐ A. -10.6 kCal/mol
- ☐ B. -7.3 kCal/mol
- ☐ C. -4 kCal/mol
- ☐ D. +4 kCal/mol
- ☐ E. +10.6 kCal/mol

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9. During each cycle of ongoing fatty acid oxidation, the following compounds are generated EXCEPT:
- ☒ A. H_2O
 - ☒ B. Acetyl CoA
 - ☒ C. fatty acyl CoA
 - ☐ D. NADH
 - ☐ E. $FADH_2$
10. All of the following describe ketone bodies EXCEPT:
- ☐ A. they are produced during starvation.
 - ☒ B. they are present in high concentrations during uncontrolled diabetes.
 - ☒ C. they are utilized by the liver during long-term starvation.
 - ☒ D. they may be excreted in the urine.
11. During production of acetoacetate in liver the immediate precursor is:
- ☐ A. beta-hydroxy butyrate
 - ☐ B. acetoacetyl CoA
 - ☒ C. beta-hydroxy butyryl CoA
 - ☒ D. mevalonic acid
 - ☒ E. beta-hydroxy-3-methylglutaryl CoA *Lyase Reaction*
12. What compound would be formed if the carbohydrate chain of a membrane ganglioside were totally removed?
- ☐ A. phosphatidyl inositol
 - ☐ B. sphingomyelin
 - ☐ C. sphingosine
 - ☒ D. ceramide
 - ☐ E. diacylglycerol
13. The reducing power ($NADPH + H^+$) for fatty acid synthesis in the cytosol is provided by:
- ☒ A. oxidation of dihydroxyacetone phosphate.
 - ☐ B. extramitochondrial oxidation of malate catalyzed by malic enzyme.
 - ☐ C. catabolism of glucose 6-phosphate via pentose phosphate pathway.
 - ☐ D. both A and B.
 - ☐ E. both B and C.

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14. Glycerol residue is present in all of the following EXCEPT:
- A. plasmalogens
 - B. lecithin
 - C. phosphatidic acid
 - D. triglyceride
 - ☒ E. sphingomyelin
15. The systematic chemical description of $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_4\text{COOH}$ is:
- 5
- A. 16:2 $\Delta^{6,8}$
 - ☒ B. 17:2 $\Delta^{5,9}$
 - ☒ C. 18:2 $\Delta^{5,9}$
 - ☒ D. 18:2 $\Delta^{6,9}$
 - E. 19:2 $\Delta^{6,10}$
- 6,9
16. The beta oxidation of unsaturated fatty acids:
- ☒ A. yields one propionyl CoA as a product.
 - ☒ B. is facilitated by an isomerase that shifts the position of double bonds.
 - C. is facilitated by a reductase that converts two trans bonds to a single cis bond.
 - D. yields an additional NADH for each double bond.
 - E. requires the formation of malonyl CoA.
17. Which of the following statements regarding fatty acid metabolism is true?
- ☒ A. NADPH is produced during the alpha-beta acyl dehydrogenase step.
 - ☒ B. FADH_2 is produced during the hydroxyacyl-CoA dehydrogenase step.
 - C. NAD^+ is consumed during the alpha-beta acyl dehydrogenase step.
 - ☒ D. Activation of palmitic acid by fatty acyl-Co synthetase yields ATP as a result of the energy released during formation of the thioester bond.
 - ☒ E. CoEnzyme A and Acyl Carrier Protein utilize the same functional group to combine with acyl groups.
18. The pathway for beta oxidation of palmitic acid:
- A. requires fatty acid export from mitochondria into the cytosol.
 - ☒ B. requires the carnitine shuttle for mitochondrial transport.
 - C. is enhanced by malonyl-CoA.
 - ☒ D. produces 8 FADH_2 during the alpha-beta dehydrogenation steps.
 - ☒ E. yields 7 acetyl-Co for each palmitic acid.

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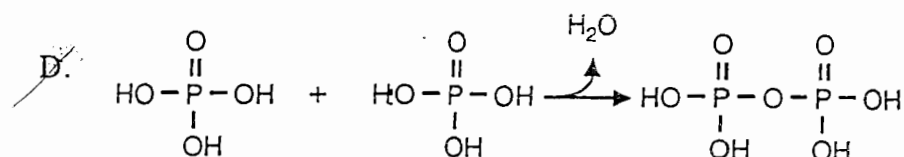
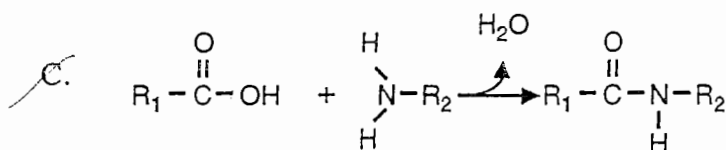
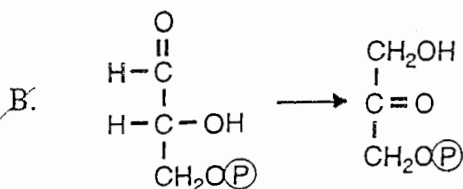
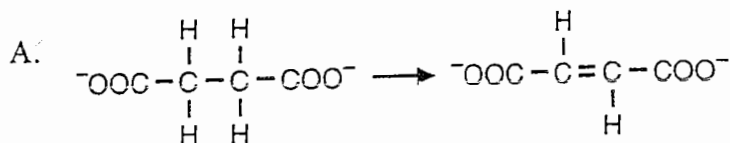
19. The following unsaturated fatty acid cannot be made from dietary precursors in humans:
- A. oleic. 18:1
 - B. palmitoleic. 16:1
 - ☒ C. linoleic. 18:2
 - D. arachidonic.
 - E. a fatty acid with a double bond in between carbons 9 and 10.
20. Fatty acid synthase:
- A. catalyzes the synthesis of only those fatty acids with fewer than 12 carbons.
 - ☒ B. is a dimeric protein that catalyzes multiple reactions needed for the synthesis of fatty acids.
 - C. is the key enzyme needed for synthesis of ketone bodies.
 - D. is primarily a mitochondrial enzyme.
 - E. utilizes FADH_2 as a redox cofactor.
21. Activation of acetyl CoA carboxylase does NOT:
- ☒ A. produce malonyl CoA.
 - ☒ B. occur in response to insulin.
 - ☒ C. stimulate fatty acid oxidation.
 - ☒ D. involve phosphorylation of the enzyme on serine residues.
 - ☒ E. lead to increased fatty acid synthesis.
22. Triglyceride biosynthesis in adipocytes:
- ☒ A. depends on the availability of glycerol.
 - ☒ B. depends on the availability of dihydroxyacetone-phosphate.
 - ☒ C. is inhibited by insulin.
 - ☒ D. depends on transport of acetyl CoA from plasma into adipocytes.
 - ☒ E. ceases when the triglyceride content reaches 10% of the weight of the adipocyte.
23. Storage of 4 nutritional calories as glycogen increases body weight by:
- A. 1 gram
 - B. 3 grams
 - C. 4 grams
 - D. 9 grams
 - E. 1000 grams
- ↓
1 g glycogen
29 40
- 1000 cal
135

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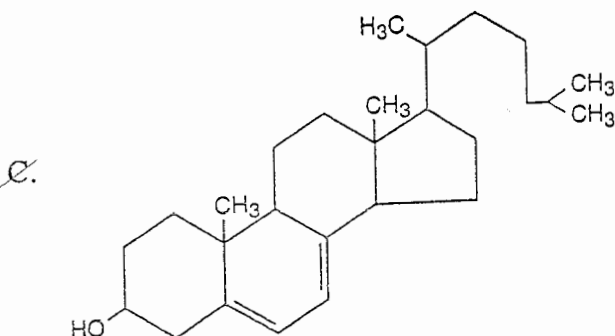
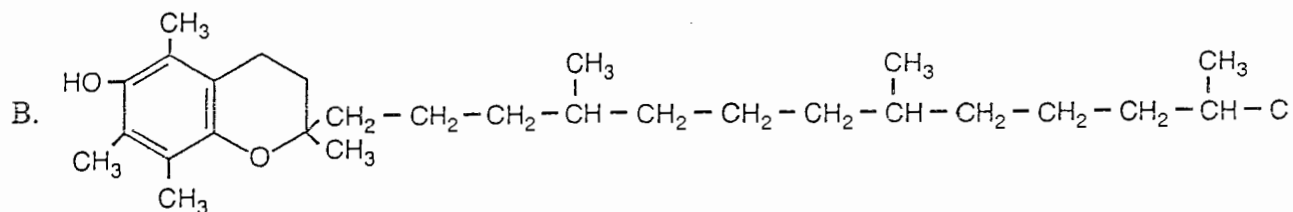
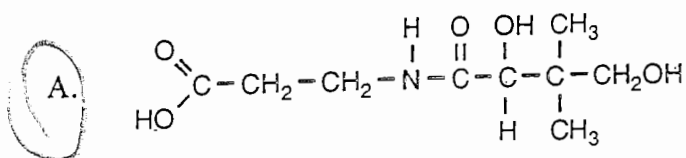
24. "Ketone" bodies include all of the following EXCEPT:
- A. beta-hydroxybutyrate
 - ☒ B. mevalonic acid
 - C. acetone
 - D. acetoacetate
25. Cholesterol biosynthesis: NMG
- ☒ A. utilizes acetyl-CoA.
 - B. utilizes malonyl-CoA as an intermediate.
 - C. occurs primarily in muscle.
 - ☒ D. is formed in the pathway for synthesis of triglycerides.
 - E. is an intermediate in the pathway for synthesis of prostaglandins.
26. Bile salts/bile acids are NOT:
- ☒ A. derived from cholesterol.
 - ☒ B. elongated forms of palmitic acid.
 - ☒ C. emulsifying agents for dietary lipids.
 - ☒ D. derivatives of tauric acid and glycine.
 - E. produced in the liver.
27. Which of the following steps is thought to be rate-limiting for the synthesis of cholesterol?
- A. Geranyl pyrophosphate to farnesyl pyrophosphate.
 - B. Squalene to lanosterol.
 - ☒ C. Lanosterol to cholesterol.
 - ☒ D. 3-Hydroxy-3-methylglutaryl CoA to mevalonic acid.
 - E. None of the above.

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28. Which of the following reactions is an example of an oxidation-reduction reaction?



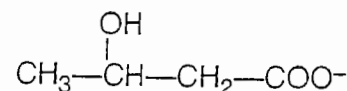
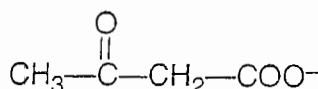
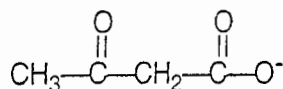
29. Which of the following vitamins structures is the MOST water soluble?



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30. Which of the following functional groups is NOT found in the structures shown below?

- A. Ketone
- B. Carboxyl
- C. Hydroxyl
- D. Methyl
- E. Aldehyde



31. Gemfibrozil (Lopid) is a drug that increases lipoprotein lipase activity therefore, it is best used to treat:

- A. highly elevated serum triglycerides.
- B. elevated LDL cholesterol.
- C. low HDL cholesterol.
- D. homozygous familial hypercholesterolemia.
- E. heterozygous familial hypercholesterolemia.

32. The maximum percentage of dietary calories from saturated fat recommended to reduce risk for coronary heart disease is:

- A. 10%
- B. 15%
- C. 20%
- D. 25%
- E. 30%

2000

$$\begin{array}{r} 22 \\ 9 \overline{) 200} \\ \underline{18} \\ 20 \end{array}$$

33. Which of these factors is not a potential cause of hypertriglyceridemia?

- A. uncontrolled diabetes
- B. obesity
- C. fasting
- D. alcohol consumption
- E. excessive consumption of sugar in foods and beverages

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34. The serum lipid indicator which best predicts risk for premature coronary heart disease is:
- A. HDL cholesterol
 - B. LDL cholesterol
 - C. VLDL cholesterol
 - D. blood triglycerides
 - E. the LDL/HDL cholesterol ratio
35. HDL₂ can return to peripheral cells to remove additional cholesterol if it is first converted back to HDL₃ by:
- A. hydrolysis of its triacylglycerol by hepatic lipase.
 - B. hydrolysis of its triacylglycerol by lipoprotein lipase.
 - C. transfer of its apoprotein E to VLDL.
 - D. transfer of its apoprotein C-II to VLDL.
 - E. transfer of its cholesterol ester to LDL.
36. One mechanism of reverse cholesterol transport involves the transfer of triacylglycerol from VLDL to HDL in exchange for:
- A. lysolecithin
 - B. linoleic acid
 - C. cholesterol ester
 - D. apoprotein A-I
 - E. apoprotein C-II
37. Maturation of nascent HDL into functional HDL₃ involves all of these processes EXCEPT:
- A. transport of nascent HDL from the liver into the blood.
 - B. transfer of additional apoproteins from VLDL and chylomicrons to HDL.
 - C. uptake of free cholesterol into the surface of HDL.
 - D. transfer of linoleic acid from the *sn*-2 carbon of lecithin to free cholesterol by LCAT.
 - E. transfer of apoprotein B-100 to LDL.
38. The ligand for binding HDL to cell membranes is:
- A. apoprotein A-I
 - B. apoprotein C-II
 - C. apoprotein E
 - D. apoprotein B-48
 - E. lysolecithin

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39. Why does the binding and uptake of LDL by macrophages trapped in the coronary arterial wall continue despite accumulation of excessive intracellular cholesterol?
- ☒ A. Feedback inhibition of LDL receptors by cholesterol is avoided by rapid conversion of free cholesterol to cholesterol ester which is rapidly transported from the macrophage into the core of the plaque.
 - ☐ B. Uptake of modified LDL by the scavenger receptor is not subject to feedback inhibition by intracellular cholesterol.
 - ☒ C. Oxidation of LDL receptors on macrophage membranes by free radicals inactivates regulator sites to which free cholesterol is normally bound.
 - ☒ D. Free radicals oxidize intracellular cholesterol ester which is not recognized by the regulatory binding site on the LDL receptor.
 - ☒ E. Scavenger receptors bind cholesterol ester to the cell membrane which prevents it from adding to the free cholesterol pool.
40. Which of these dietary compounds downregulates LDL receptors?
- ☒ A. soluble fiber
 - ☒ B. allicin in garlic
 - ☒ C. monounsaturated fatty acids
 - ☒ D. polyunsaturated fatty acids
 - ☒ E. *trans*-fatty acids
41. Which of these statements concerning the LDL receptor is TRUE?
- ☒ A. LDL receptors are found only on hepatic cell membranes.
 - ☒ B. LDL receptors are located in pits of the cell membrane coated with the protein, clathrin.
 - ☒ C. Clathrin binds apoprotein B-100 on LDL.
 - ☒ D. LDL receptors are catabolized (degraded) with LDL in lysosomes.
 - ☒ E. LDL receptors in liver cells bind only LDL.
42. The rate limiting enzyme for hydrolysis of triacylglycerol in adipose tissue is hormone-sensitive lipase. Its activity is increased or decreased by other enzymes or metabolites. Select the INCORRECT statement describing modulation of hormone-sensitive lipase activity.
- ☒ A. Cyclic AMP-dependent protein kinase increases its activity.
 - ☒ B. Lipase phosphatase decreases its activity.
 - ☒ C. Adenylyl cyclase decreases its activity.
 - ☒ D. Phosphodiesterase decreases its activity.
 - ☒ E. Free fatty acids decrease its activity.

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43. Which of these factors decreases mobilization of FFA from adipose tissue?
- A. epinephrine
 - B. glucagon
 - ☒ C. eating a high carbohydrate meal
 - D. caffeine
 - E. exercise
44. Which of the following is NOT a correct statement of VLDL function?
- A. VLDL transports cholesterol out of the liver.
 - ☒ B. VLDL transports triacylglycerol from liver to adipose, muscle and other peripheral tissues.
 - ☒ C. VLDL participates in reverse transport of cholesterol to the liver.
 - ☒ D. VLDL is the precursor of LDL.
 - ☒ E. VLDL transfers triacylglycerol to adipose tissue in exchange for cholesterol.
45. A major source of cholesterol in chylomicrons, other than that digested and absorbed from animal foods, is:
- A. cholesterol synthesized from acetyl-CoA in the intestinal mucosal cell.
 - ☒ B. cholesterol from bile.
 - ☒ C. cholesterol from plant oils in food.
 - D. cholesterol taken up by chylomicrons from adipose tissue.
 - E. cholesterol transferred to chylomicrons from LDL.
46. By what mechanism does insulin promote conservation (storage) of triacylglycerol in the fed state?
- A. activation of hepatic lipase
 - B. activation of hormone-sensitive lipase
 - ☒ C. activation of lipoprotein lipase
 - D. activation of cyclic-AMP synthesis in adipose tissue
 - E. inhibition of apoprotein C-II
47. The primary lipid transported to the liver by chylomicrons is:
- ☒ A. cholesterol ester
 - ☒ B. triacylglycerol
 - C. free fatty acids
 - D. phospholipid
 - E. 2-monoglyceride

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48. What would be the expected effect on chylomicron metabolism from a genetic defect resulting in abnormal apoprotein E?
- ☐ A. decreased synthesis of chylomicrons in the intestinal mucosal cell.
 - ☐ B. abnormally high concentration of large chylomicrons in the blood.
 - ☒ C. abnormally high concentration of chylomicron remnants in the blood.
 - ☐ D. inhibition of chylomicron binding to lipoprotein lipase.
 - ☐ E. no change in chylomicron metabolism.
49. Which pair of apoproteins is transferred to chylomicrons by HDL?
- ☐ A. apoproteins A and B-48
 - ☒ B. apoproteins C and E
 - ☐ C. apoproteins A and E
 - ☐ D. apoproteins B-48 and C
 - ☐ E. apoproteins B-48 and B-100
50. Which of these statements regarding 2-monoacylglycerol is FALSE?
- ☐ A. 2-Monoacylglycerol is a major end product of triacylglycerol digestion.
 - ☒ B. Esterification of 2-monoacylglycerol with acyl-CoA is the major pathway for triacylglycerol synthesis in intestinal mucosal cells.
 - ☐ C. Formation of micelles is facilitated by the amphipathic nature of 2-monoacylglycerol.
 - ☐ D. The ester bond of 2-monoacylglycerol is resistant to hydrolysis by pancreatic lipase.
 - ☒ E. Hydrolysis of triacylglycerol by lipoprotein lipase results in the accumulation of 2-monoacylglycerol in chylomicron remnants.
51. MCT (Medium Chain Triglyceride) oil can be used as a fat source for patients with pancreatic malfunction because:
- ☐ A. it does not require hydrolysis of its esterified fatty acids before being absorbed.
 - ☒ B. it has twice the caloric density of triacylglycerol in food, thus, less needs to be consumed.
 - ☐ C. it is more readily incorporated into chylomicrons for transport.
 - ☐ D. it does not require emulsification by bile salts with subsequent hydrolysis by lipase.
 - ☒ E. its metabolism is not influenced by insulin.
52. Uptake of cholesterol from the blood by the liver is primarily regulated by modifying the synthesis or activity of:
- ☐ A. hepatic lipase
 - ☐ B. lecithin:cholesterol acyltransferase (LCAT)
 - ☐ C. cholesterol ester transfer protein (CETP)
 - ☐ D. the scavenger receptor
 - ☒ E. the LDL receptor

MEDICAL BIOCHEMISTRY EXAMINATION I - FORM A

53. Select the CORRECT sequence of lipids in order of increasing amphipathic property, starting at the inside center and proceeding to the outer surface of a lipoprotein.

- A. cholesterol ester: unesterified cholesterol: phospholipid
- B. free cholesterol: cholesterol ester: phospholipid
- C. phospholipid: free cholesterol: cholesterol ester
- D. triacylglycerol: free cholesterol: cholesterol ester
- E. free cholesterol: triacylglycerol: cholesterol ester

54. Which statement correctly describes the relationship between lipid metabolism and coronary heart disease?

- A. Excessive amounts of triacylglycerol accumulate in adipose cells which infiltrate into damaged areas of the coronary artery epithelium.
- B. Unsaturated fatty acids are oxidized by free radicals resulting in the accumulation of lysolecithin in modified smooth muscle cells of the coronary artery.
- C. Saturated fatty acids when consumed in excess are transported by LDL and taken up by macrophages in the wall of the coronary artery.
- D. Macrophages infiltrate injured areas of the endothelium of coronary arteries and accumulate cholesterol ester transported by LDL.
- E. Unesterified cholesterol is transported by HDL to the coronary arteries where it accumulates on the epithelium and is encapsulated with a fibrous cap to form a plaque.

